RESEARCH FOR FARMERS

WINTER 1966

ROOT GROWTH PATTERNS IN WHEAT VARIETIES

COLD STORAGE OF CHRYSANTHEMUM CUTTINGS

BROADLEAF AS A DYKELAND CROP

IRRIGATED PASTURES IN SOUTHERN BRITISH COLUMBIA

SALT CONTENT CHANGES IN IRRIGATED SOILS

EVAPORIMETERS USED TO SCHEDULE IRRIGATION IN BRITISH COLUMBIA

CANADA DEPARTMENT OF AGRICULTURE

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Cover Photo—White and black weave their familiar patterns as winter takes over once again on the farm.

NOTES & COMMENTS

E. A. Hurd, (p. 3), says that the roots of wheat varieties appear to differ as much as the above-ground parts; varieties respond differently to moisture stress. While the extent and pattern of root development of varieties does not completely account for differences in ability of different varieties to produce grain under dry prairie conditions, there does seem to be a relationship. Hurd discusses a method of studying roots which he thinks has value and he is using the information in the selection of parents for crosses in the breeding program at Regina.

* * *

From Kentville, Lockhart and Swain (p. 6) report that chrysanthemum stool cuttings dug in the fall produced normal flowering plants following 6 months' storage in controlled temperatures of 28°F. to 34°F. . . . . From Nappan, Nicholson and Langille (p. 8) tell what they learned about the nutritive value and production of broadleaf grass as a dikeland crop . . . . . Hubbard, Kamloops, (p. 10) writes about the place of irrigated pastures in B.C.'s southern interior; he states that the livestock carrying capacity of an adequately irrigated farm or ranch can be increased by establishing a mixed grass-legume pasture, and forecasts the possibility of producing a thousand pounds of beef per acre . . . . . Pojakas, Swift Current, (p. 12) discusses soluble salt content changes in irrigated soils; average forage crop yields from irrigated land (in their survey) ranged from 1.5 to 2.0 tons per acre—considered a relatively stable yield during the last 10 years. "High salt content of the soil, very little use of fertilizer and aging forage stands, we discovered, were major factors keeping production well below optimum levels" . . . . . . Wilcox, Summerland, (p. 14) reveals that scheduling of irrigiation in the Okanagan Valley has been beset with difficulties not usually mentioned in reports from elsewhere. Chief among these have been variations in climate and soils, of sufficient magnitude that the number of irrigations per year varies from as few as one in clay loam soil in a cool year to as many as 30 in a sandy soil in a hot year.

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ROOT GROWTH

THEIR PATTERNS DIFFER IN WHEAT VARIETIES

E. A. HURD

"Out of sight, out of mind" may be the reason for forgetting the large part of a wheat plant which is below ground. Perhaps it is not surprising that researchers have concentrated on the above-ground parts of plants. This is what we see and the part most easily studied. However, as research becomes more specialized, workers are giving more consideration to plant roots. This is a report on some root studies which are being made as part of the wheat breeding program at the Regina Experimental Farm.

The purpose of the breeding program is to develop varieties with the ability to yield well under dry prairie

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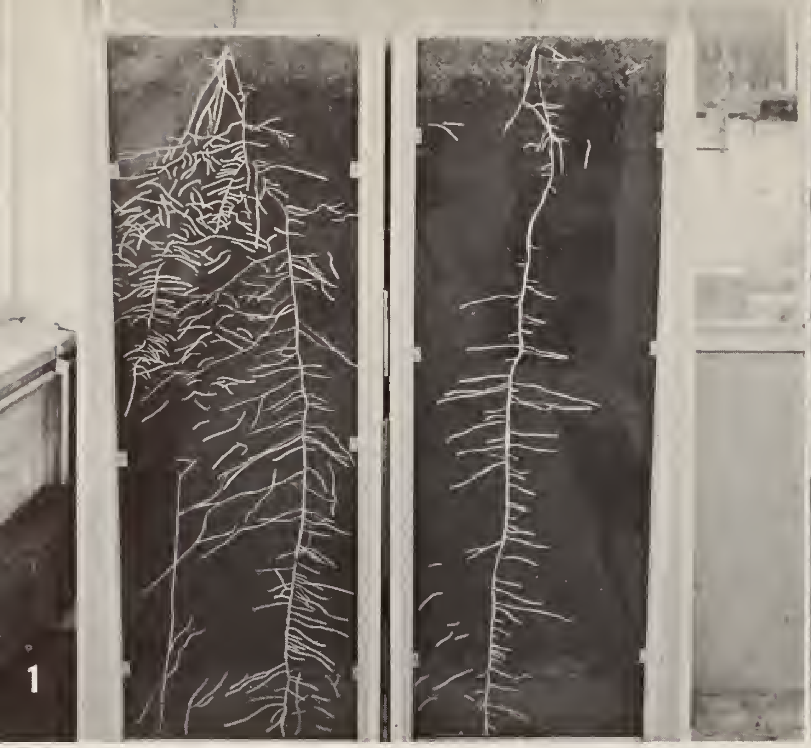
The author is a cerealist at CDA Experimental Farm. Regina, Sask.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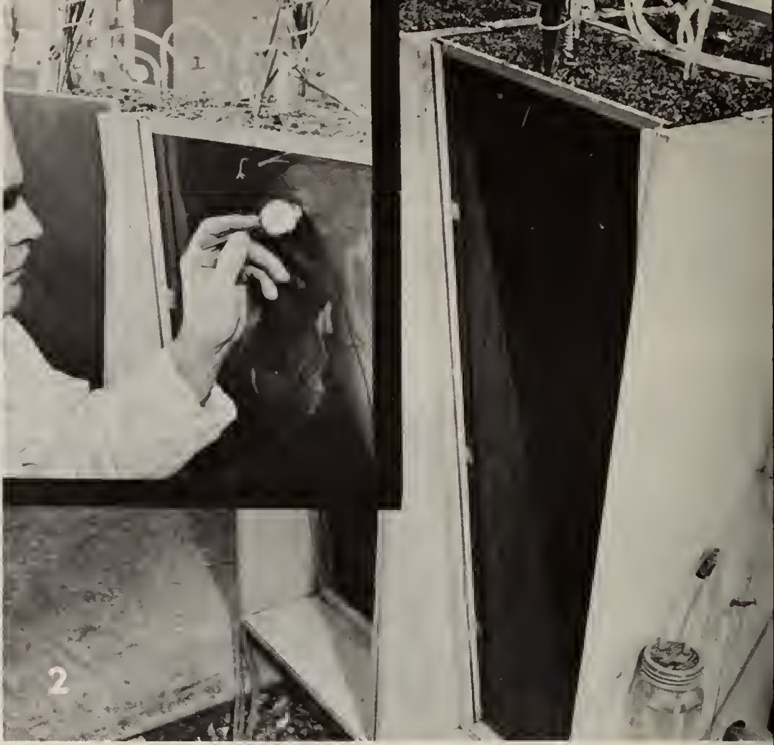
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conditions. This might be called "drought resistance" but really scientists do not know what makes some plants survive and produce better than others under water stress. To say that drought is a shortage of water is an over-simplification but to the prairie farmer a good rain at the right time will often dispel the drought hazard. Yield of grain under different moisture conditions is a measurable characteristic so it will be used here as the final product of the plants.

Some workers have found that light is the limiting factor in their region. They have studied such characters as leaf area, leaf angle and plant spacing. In southern Saskatchewan, long clear days and relatively thin crop stands make light plentiful. Soils are fertile. Few will question that water is the chief limiting factor on much of the Canadian prairie, and indeed, throughout most of the cereal production area of the world. Farmers cannot make it rain but increases in yield in the last 10 to 20 years reflect better water conservation. Can varieties be improved to make better use of available moisture?

Since soil is a reservoir of moisture, one might assume that plants which produce well in arid conditions must develop roots which penetrate deeply, extend widely and are heavily branched. Such a root system will make it possible for plants to absorb the available moisture, if and when needed. At Regina, we wondered how widely varieties differ in their pattern of root growth. In an attempt to study wheat roots we built 4-feet-tall boxes that had a sloping glass front (Figure 2). One plant was sown next to the glass in each box. We observed the roots as they grew and measured them week by week. At maturity we washed away the soil, recovered and weighed the roots from each soil level in the box (Figure 3). Each variety was grown at two levels of moisture. The soil in both sets was above field capacity at the start. The "wet" level was watered regularly while the "dry" was never watered from seeding to harvest. The boxes were filled with the Regina heavy clay profile. Self-watering devices were installed in the boxes in the most recent tests (Figure 2).

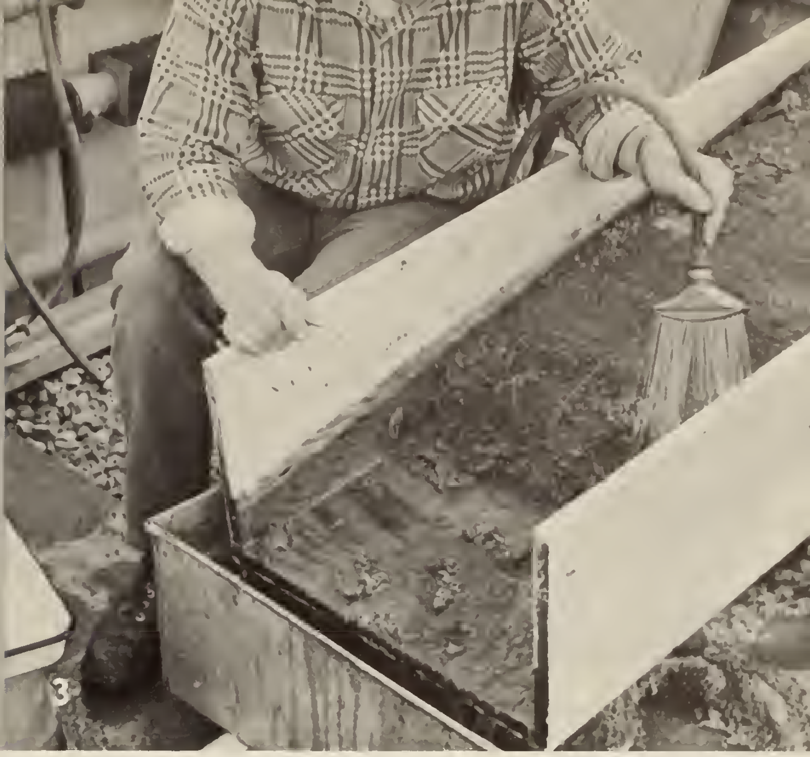
The first three varieties compared gave three different patterns of growth. They were Thatcher and Cypress bread wheat and Pelissier durum, all of which are well adapted to dry prairie conditions. Thatcher and Pelissier are well known for their ability to survive and produce crops when moisture is severely limited. It was observed that Thatcher has a slightly greater root system than Cypress when moisture is adequate. When moisture was limited the soil dried out near the surface where most varieties have a preponderance of roots. Thatcher produced additional branches in the moist layers of soil below the dry zone while Cypress did not. The apparent ability of Thatcher to compensate for loss of effective roots may be the reason for its superiority over Cypress under dry conditions. The yield of these two varieties in well-watered soil was similar but Thatcher produced twice the yield of Cypress in one experiment when moisture in non-watered boxes was extremely limited. Thatcher produced more roots in "dry" soil than in "wet" in one experiment.

Pelissier had another pattern of growth. This variety had relatively few roots near the surface and did not penetrate beyond the 3-foot level but its root system was much denser than for the other varieties. Pelissier had more primary roots and produced more roots as

Fig. 1—Roots of Thatcher (left) and Lemhi (right) showing on the glass were traced on a clear plastic overlay.

Fig. 2—Root growth boxes with light shield removed to expose roots for measurement. Self-watering to a constant moisture level is made possible by devices installed.

Fig. 3—Growth boxes are submerged in tank of water overnight. Glass is then easily removed and soil sprayed from roots.



measured by weight as well as by length on the glass than Thatcher or Cypress. Because of the scarceness of roots near the surface, Pelissier grew well in non-watered boxes. Soil drying near the surface did little damage to the roots until near the heading stage. By this time Pelissier had a tremendous root system between the 8 and 36 inch levels. We concluded that Pelissier is resistant to drought partly because of its very extensive root system and because it does not produce many roots near the surface.

In the most recent studies we introduced varieties of common wheat, Koga II from Britain, Narino and Nainari from Mexico and Lemhi from the soft wheat areas of this continent. These were compared with Thatcher and two hybrid lines developed at Regina, CT 262 and Q631-11. All of these varieties penetrated the soil at about the same rate when moisture was plentiful. When no water was added after planting, roots of Thatcher reached the four-foot depth two weeks sooner, and of Q631-11, Lemhi and Narino, one week sooner, than when water was added. Roots of other varieties penetrated the soil at about the same rate at both moisture levels. Q631-11 had nearly as much root showing on the glass in dry boxes as Thatcher, and Nainari had more root by weight, but neither of these varieties produced as much seed as Thatcher. When moisture was high Q631-11, Koga and Nainari produced more root by weight and by measurement on the glass than Thatcher. They also yielded more. None of the other varieties produced as many roots or yielded as much as Thatcher. This suggests that there is a relationship between amount of root and yield. Q631-11, according to measurement on the glass, produced only slightly more root than Thatcher by heading time, but unlike any other variety, it continued to produce new roots for more than two weeks after heading. Other than root hairs, which could not be measured in this experiment, root growth usually stopped at heading time.

Growth of roots was slow and steady for the first five weeks for all varieties. The growth rate of roots of varieties in the Thatcher maturity range accelerated rapidly during the sixth to eighth week and then levelled off as heads emerged. The root growth of the Mexican variety, Narino, did not have an acceleration period but continued at the relatively slow rate until heading time which was several days earlier than the heading date of Thatcher. Growth of roots of Lemhi, which was ten days later than Thatcher in the non-watered boxes, did not start to accelerate until the eighth week. When measured in the seventh week, the total length of roots of Thatcher was about twice that of Lemhi (Figure 1). The large difference in amount of root is the result of two factors: the difference in stage of maturity and the difference in variety response to a shortage of moisture. Thatcher produced more roots in non-watered soil than in watered soil, whereas, Lemhi produced less.

The roots of varieties appear to differ as much as the above-ground parts. Varieties respond differently to moisture stress. While the extent and pattern of root development of varieties does not completely account for differences in ability of different varieties to produce grain under dry prairie conditions, there does seem to be a relationship. We think that this method of studying roots has value and we are using the information in the selection of parents for crosses in the breeding program. ●

COLD STORAGE OF CHRYSANTHEMUM STOOL CUTTINGS

Experiments show that cuttings prepared for storage do better when 'stripped'—that is when all foliage except small leaves surrounding the growing point are removed—and when stored in polyethylene bags at 28° to 34°F.

C. L. LOCKHART and G. S. SWAIN

Premature development of flower buds of many varieties of garden chrysanthemums when propagated by stem cuttings greatly reduces production of flowers and foliage. Methods of vegetative production to circumvent this difficulty are therefore of great importance to florists since stock plants of many varieties of garden chrysanthemums cannot be maintained under glass in a vegetative state. Some varieties can be propagated from stool cuttings of plants left out all winter. However, many varieties are susceptible to winter injury and an alternate method of propagation is required.

In exploratory work at Kentville with stool cuttings taken from field-grown stock plants potted in peat pots and overwintered in a cold frame, only a third of the cuttings survived and produced good plants. Some workers report that rooted chrysanthemum stem cuttings can be safely stored for 5 weeks at 33°F. In our investigations we found that stool cuttings having all their foliage and stored in polyethylene bags at 35°F. became severely rotted within one month. We also discovered that removing excess foliage extended the storage life.

In more extensive tests, we studied the effect of fungicidal treatments, storage temperatures and the removal of foliage on the storage life of chrysanthemum fall stool cuttings. We prepared stool cuttings of Kentville seedling 6-56 for storage in early November. Before digging, we cut back the current year's growth to expose new stool growth and cut the stool cuttings that were 3 to 4 inches long. Where the foliage was removed except for small leaves surrounding the grow-

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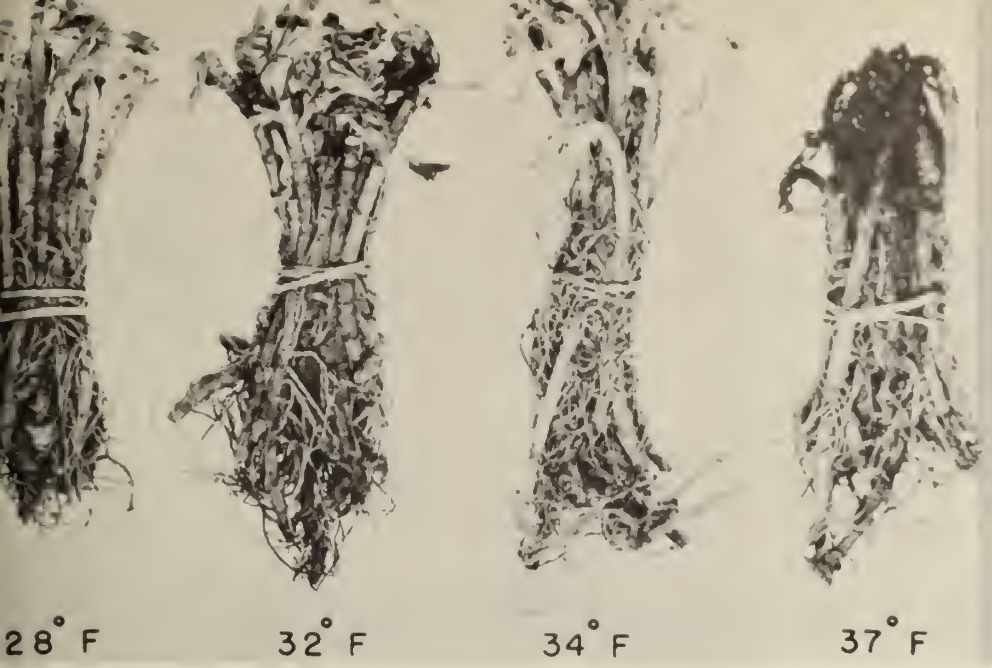
Messrs. Lockhart and Swain are specialists in storage diseases, and ornamentals, respectively, CDA Research Station, Kentville, N.S.



Bundles of Chrysanthemum stool cuttings from different storage temperatures.

ing point, these are referred to as *stripped* cuttings, and those having no foliage removed are *unstripped* cuttings. The cuttings were divided into bundles of 25 and each bundle was placed in a small polyethylene bag pulled close with string and metal rim tags and stored at 28°F., 32°F., 34°F., or 37°F. After 6 months, the cuttings were removed from storage and planted in peat pots in a standard potting soil mix in a mist propagation bed to be rooted. After 2 weeks they were removed from the mist and subsequently planted in the field to follow their development.

Our research revealed that unstripped chrysanthemum stool cuttings stored from November to May were severely rotted with most having dead growing points. Few grew in the mist propagation bed and none produced normal healthy plants. On the other hand, we found that most of the stripped cuttings stored at 37°F. had rotted tips (see Figure) and did not produce terminal growth in the mist propagation bed but a few weak laterals often grew from this type of cutting. When partial rotting occurred only on other parts of the cutting, normal healthy plants were usually produced. The results in the accompanying table show that the temperatures from 28 to 34°F. were much more favorable for the storage of chrysanthemum cuttings with most of them producing normal terminal growth. More cuttings were partially rotted at 32 and 34°F. than at 28°F. But these rots had little effect on the survival of the cuttings and subsequent development into normal plants.

Several fungicide treatments such as Erad (phenyl mercury acetate) field sprays prior to taking the cuttings in the field or treating the cuttings with Thylate dip or dust prior to storage had no effect on the development of storage rots or subsequent development of the cuttings into mature plants.

In one experiment we found that cuttings stored at 28°F. were injured when, on five occasions, the temperature dropped to 22°F. for 2 to 4 hours. These injured cuttings were badly dehydrated and shrivelled but 58 per cent produced normal healthy plants.

These experiments show that chrysanthemum stool cuttings dug in the fall produced normal flowering plants following 6 months' storage in controlled temperatures of 28°F. to 34°F. In preparing cuttings for storage, it is recommended that all foliage except small leaves surrounding the growing point be removed and that the cutting be stored in polyethylene bags at 28°F. to 34°F.

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PERCENTAGE SURVIVAL AND TYPE OF GROWTH OF CHRYSANTHEMUM STOOL CUTTINGS WITH EXCESS FOLIAGE REMOVED AND STORED AT VARIOUS TEMPERATURES

	Type of growth					
	Terminal		Lateral		No growth	
Temperature °F	1963	1964	1963	1964	1963	1964
28	99	58[1]	1	42	0	0
32	94	95	5	5	1	0
34	86	97	11	3	3	0
37	0	49	77	51	23	0

[1] Freezing injury at 28°F.

BROADLEAF

J. W. G. NICHOLSON and J. E. LANGILLE

Broadleaf hay grown on the dikeland surrounding the Bay of Fundy in Nova Scotia and New Brunswick is still managed much as it was by the Acadian settlers who first diked the marshes in the 1600's.

Broadleaf is the local name for *Spartina pectináta* (Link) a variety of cordgrass that grows on reclaimed salt marshes. It is more tolerant of poor drainage and high salinity than other species of grasses cultivated in the area. Although now grown only on the less well developed dikeland, it is estimated to still occupy about 28,000 acres and contributes significant amounts of animal forage. The genus *Spartina* is found growing on tidal marshes throughout the world and on the alkali sloughs of western North America.

The traditional procedure is to allow broadleaf, which flowers in late August, to set seed and then harvest the mature forage in September. Late harvesting is practiced partly for traditional reasons and partly from necessity. Because broadleaf is grown on the more poorly drained areas it is easier to get farm machinery on this land late in the summer. It is also known that broadleaf stands will not persist under conditions of frequent defoliation such as pasturing or multiple cutting for hay or silage.

Despite the long history of use of this species as animal forage, its agronomic and nutritive characteristics were never thoroughly investigated. In an experiment recently completed at the CDA Experimental Farm, Nappan, N.S. here is what we learned about broadleaf grass:

In the agronomic studies, we included the effects of cutting at four stages of development (leaf, boot, head and seed), each at three stubble heights—$1\frac{3}{4}$, 3 and 5 inches—and with or without the application of 75 lb. of nitrogen per acre. The treatments were applied to the same area for three consecutive years to determine their effect on persistence of the sward.

The broadleaf almost completely disappeared and was replaced by less productive marsh bent grasses when the forage was cut at the leaf (late June) or boot stage (late July) and again as aftermath. The stand was also severely thinned when harvested at the fully headed stage (late August) but remained unchanged when harvested once per season at the seed stage (late September). The application of nitrogen in late June also reduced the number of broadleaf plants per square yard but increased the total yield of forage by 33% when all cutting treatments were averaged over a 3-year period.

Fig. 1.—Broadleaf growing on a typical dykeland area.

Our yields of forage varied from a low of 1200 lb. of dry matter per acre for the earliest cutting at the highest stubble height in the third year of harvest to a high of 7170 lb. of dry matter for the latest cutting at a 3-inch stubble height with nitrogen applied in the second harvest year. Over the three-year harvest period, yields declined from the first to the third harvest year by 48% for the plots cut at the leaf stage, 41% for the boot stage, 32% for the head stage and only 9% for the seed stage. We found that height did not affect yields appreciably for the $1\frac{3}{4}$- and 3-inch stubble, while yields from the plots at the 5-inch stubble heights were 15% lower over the 3-year period.

Forage harvested at the vegetative stage (June 18), boot stage (July 31), head stage (August 23) and seed stage (September 26) was chopped into 2-3 inch lengths, dried and fed to yearling wethers. We determined the amount of feed that the sheep would voluntarily consume per day during a preliminary feeding

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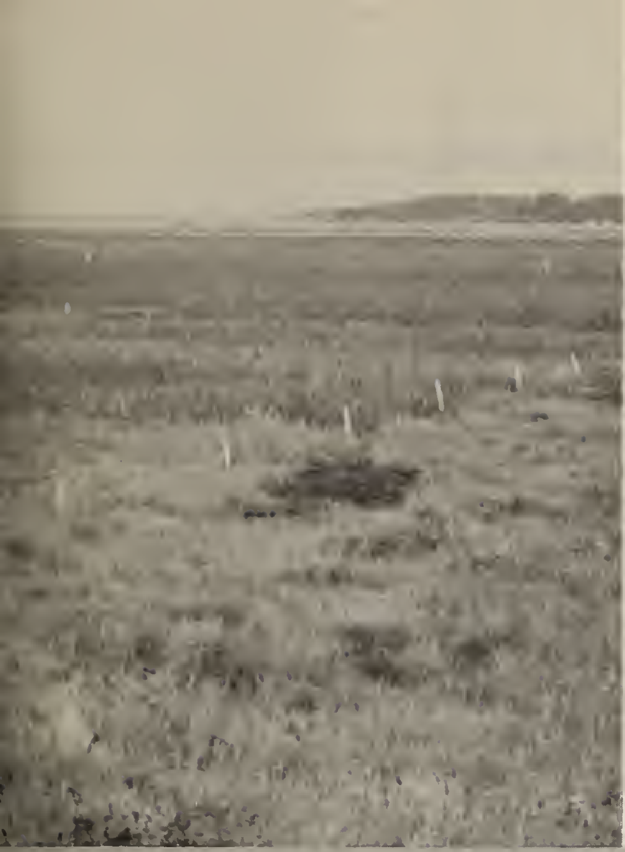
James Nicholson is an animal nutritionist and James Langille an agronomist, forage crops, CDA Experimental Farm, Nappan, N.S.



Plot area in mid-June after 3-year experiment
lote vigorous stand of broadleaf still on plots
vanced maturity.

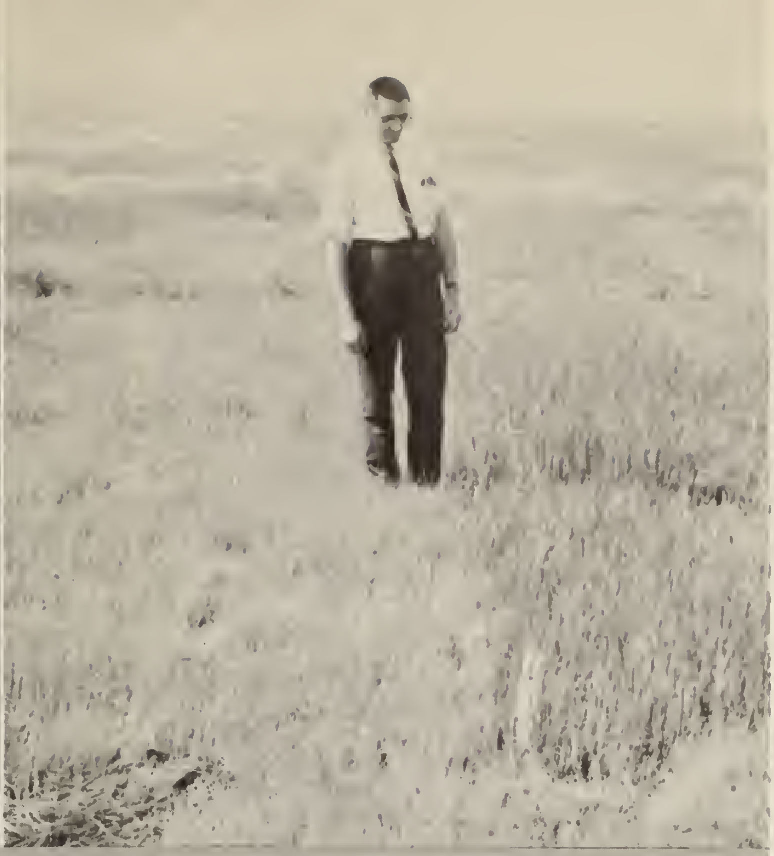


Fig. 3.—Two plots in mid-June after 3 years of experiments: (left) almost no broadleaf on plot harvested at boot stage; (right) good stand on plot harvested at seed stage.

AS A DIKELAND CROP

ITS NUTRITIVE VALUE AND PRODUCTION

period. Then we fed slightly less than this amount for a 3-week period during which digestibility of the forage was determined.

In this investigation we found that the digestibility of the dry matter declined at a relatively constant rate of 0.2 per cent units per day from a high of 61.9% on June 18 to 42.7% on September 26. The amount of dry matter consumed per sheep per day declined sharply at first and then more slowly from a high of 996 grams to 509 grams as the forage matured. Since the digestibility of the dry matter was also declining the intake of digestible dry matter declined from 617 to 217 grams per day. The latter level was insufficient to meet the maintenance energy requirement of the sheep used in the experiment.

Our research revealed that fertilizing with nitrogen improved the digestibility of the dry matter and crude protein but did not result in higher feed intakes by the sheep fed the forage.

It is widely believed that broadleaf hay retains its nutritive value better than the earlier maturing "tame" hay. Timothy, which normally flowers and sets seed about eight weeks later than broadleaf, was grown on dikeland and harvested at similar stages of maturity for comparison. Early in the season we found that the timothy was slightly more digestible but it declined in digestibility faster and by late August the broadleaf was more digestible than timothy. However, the maximum difference at any time in the dry matter digestibility coefficient for the two species was only 2.5 per cent units.

The system of management worked out by the Acadian settlers 300 years ago is the only feasible one, if stands of broadleaf are to be maintained. However, forage harvested at such an advanced stage of maturity is of low quality and cannot be expected to support high rates of animal production. ●

IRRIGATED PASTURES

IN THE SOUTHERN INTERIOR OF B.C

WILLIAM A. HUBBARD

At the CDA Research Station, Kamloops, B.C., we have discovered that the livestock carrying capacity of an adequately irrigated farm or ranch can be increased by establishing a mixed grass-legume pasture.

Our investigations involved the use of three grass-legume mixtures grazed in rotation with adequate water and fertilizer. It has been demonstrated that depleted irrigated pastures have a per acre carrying capacity of one animal unit or less for the grazing season, while improved irrigated pastures will sustain from two to four animal units per acre. At the Research Station, Kamloops, we have found the most productive grass-legume irrigated pasture for the southern interior of British Columbia consists of brome, orchard, and ladino clover. The rates are 12 pounds of brome, 8 pounds of orchard, and one pound of ladino clover. This mixture when seeded properly, fertilized and watered according to recommendations,

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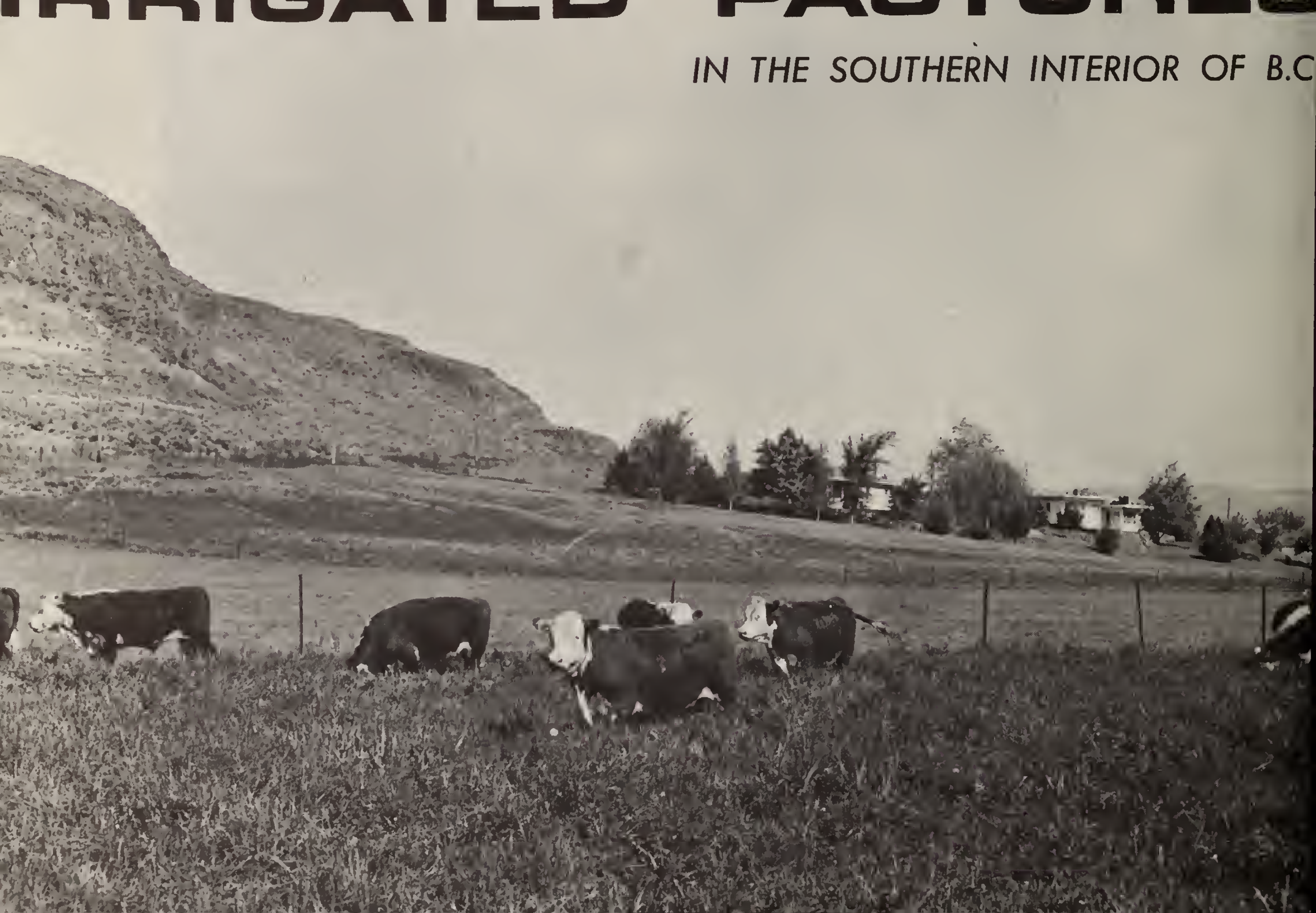

Fig. 1.—Pastures under irrigation in southern interior of B.C. with a grass-legume mixture of brome, orchard and ladino clover will sustain from 2 to 4 animal units per acre.

will yield over 800 pounds of beef per acre, or the equivalent in lamb or milk.

Our work has been mainly with beef cattle as we are in the heart of the ranching industry in British Columbia. The trend has been to use yearling steers because older animals are likely to become excessively heavy at the time of slaughter and calves would not obtain sufficient size and finish to be acceptable slaughter animals. However, in selecting and managing livestock for pasture we have given consideration to whether the maximum production per acre or per animal is the most desirable. We have felt that maximum production per acre is the best criterion on which to base rates. We have found that maximum production per acre is obtained by using young growing animals and high stocking rates. Our research to date indicates that three head of yearling steers per acre on a three-field rotation system is the best method of obtaining maximum beef production and at the same time maintaining the pasture in good condition.

In our investigations at Kamloops, we have also shown that gains can be increased one-third to half a pound a day by the use of hormone implants. Implanted steers that graze grass-legume pastures such as recommended for the area consume more TDN per acre than non implanted steers. However, it has been shown that implanted steers require less TDN per pound of gain. It has been said that implanting is like putting a super charger on a car; you have to provide the fuel to get maximum results. Irrigated pastures are able to provide this fuel for livestock.

We have found that in terms of feed equivalents the forage yield of a well managed irrigated grass-legume pasture compares favorably with an alfalfa field. The best way to show this is to quote some figures on costs. On a three-cut basis we are able to produce at least six tons of hay per acre. If we assume that the selling price of hay is $25 a ton and we estimate it cost $12 a ton to put up, then the net return per acre is $78. Using beef to assume a pasture value we know we can produce at least 825 pounds per acre. If we assume beef prices to be 22¢ and we estimate it costs 12¢ per pound to produce this, the net value per acre is $82.50.

As time progresses we intend to try other mixtures and different management techniques to increase our returns of beef per acre. This is already possible by the use of hormone implants which will increase beef production up to one-third of a pound per day per animal. Four and five field rotations have yet to be tried. Perhaps feeding grain on pastures will be an economic proposition. It is our aim to produce a thousand pounds of beef per acre in the not too distant future. ●

Fig. 2.—Properly seeded, fertilized and watered, mixtures of brome, orchard and ladino clover will yield over 800 lbs. of beef per acre, or the equivalent in lamb or milk.

Top—Part of the Eastend gravity irrigation project.

Bottom—A spring flood scheme near Swift Current.

SALT CONTEN CHANGES IN IRRIGATED SOILS

K. POHJAKAS

The introduction of irrigation to dry land brings about many changes that affect the productive capacity of these soils. Additional moisture creates conditions entirely different from the moisture deficient environment that previously controlled the production on dry land. Drainage patterns and the soluble salt content of irrigated soils appear to be the features that are most noticeably affected.

In a study conducted at Swift Current in the brown soil zone of the south-central prairies, we found that irrigation causes a general translocation of soluble salts in the soil profile. An upward move-

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ment of soluble salts occurs where drainage is inadequate or where insufficient water is applied, limiting the downward leaching effect. In very tight clay soils, which form a large part of irirgated soils in Saskatchewan at present, we discovered that the permeability is so slow that the evapotranspiration use of water exceeds many times the amount of water moving downward. Such conditions contribute very little to the normal leaching process and the salt movements are mostly towards the soil surface, resulting in an increase of soluble salts in the upper part of the root zone.

In the course of our study of salt content changes in irrigated soils, we examined the records of detailed soil analyses of samples collected between 1940 and 1953 at several irrigation projects in Saskatchewan. These showed a slight to tenfold increase in the sodium content in the top three feet. SO_4 content of the same set of samples varied from decreases at some sites to a general increase that amounted in places to a twentyfold rise of the original SO_4 content. The calcium content showed a general decreasing trend at most locations and was more noticeable at sites where an increase in the sodium content had occurred.

SOLUBLE SALT CONTENT FINDINGS

In our current investigation, we found that changes in the soluble salt content are strongly influenced by the parent material. Where the subsoil had a high soluble salt content, the upward movements were more pronounced and at these locations the salt content became a problem affecting productivity. We also noticed that salt movements below the three-foot depth of the soil are less definite and about evenly divided between increases and decreases, the latter being more numerous.

In seepage-affected areas, where high water tables prevailed during the sampling period, we discovered the total salt content had increased to a much greater extent, rendering affected areas saline or alkaline and sometimes unfit for production.

Our research revealed that high water tables caused by seepage or inadequate drainage are invariably associated with rapid salt build-ups and unfavorable conditions for plant growth. According to the soil analysis records we studied, the highest salt contents were reached in 1949 to 1951 at several locations in southwestern Saskatchewan. Since then, improved drainage, more accurate land levelling, and better seepage control have contributed to a general improvement in these areas. Improved management practices and a better understanding of irrigation farming have also been major contributing factors controlling further deterioration of irrigated lands and have been conducive to a limited amelioration of severely saline lands. According to our present investigation, the widespread use of perennial crops in contrast to the formerly popular cereal crops of the early days, has had a restricting effect on the salt movements. And, in addition, we also found that where a good plant cover is maintained on saline areas a rapid accumulation of salts near the soil surface is largely prevented.

In our current study, we learned that the average forage crop yields from irrigated land in the survey area ranged between 1.5 to 2.0 tons per acre. This yield range has been relatively stable during the last 10 years. High salt content of the soil, very little use of fertilizers and aging forage stands, we discovered, were the major factors keeping production well below its optimum levels.

SPRING FLOOD SCHEME BEST

Very little sprinkler irrigation is used in southern Saskatchewan; spring flood and gravity-type summer irrigation are the two dominant systems. Numerous spring flood schemes have been in operation for over 50 years. Spring flood systems appear to contribute less to the build-up of salts in the soil profile than the regular summer irrigation methods. The fact that spring flood systems are located near a natural water course or river channel and have no artificial water distribution systems which cause most of the seepage troubles, is undoubtedly a factor in favor of keeping ground water tables under control. Spring flooding takes place early in the spring during the cool weather which is again less conducive to upward movement of salts. The natural streams act later as drainage channels for the spring flooded land, providing natural drainage for removing surplus water. The regular summer irrigation projects, on the other hand, are often located on old lake bottoms where drainage is difficult even with a good network of man-made drains. All spring flood schemes included in this study compare favorably with the summer irrigated areas in respect to soil salinity.

In summary, our study has shown that productivity on the majority of irrigation projects can be maintained with careful management that includes adequate drainage and seepage control in addition to improved irrigation and cropping practices. Spring flood schemes appear to offer better salinity control and provide livestock feed with a smaller investment of capital and labor. ●

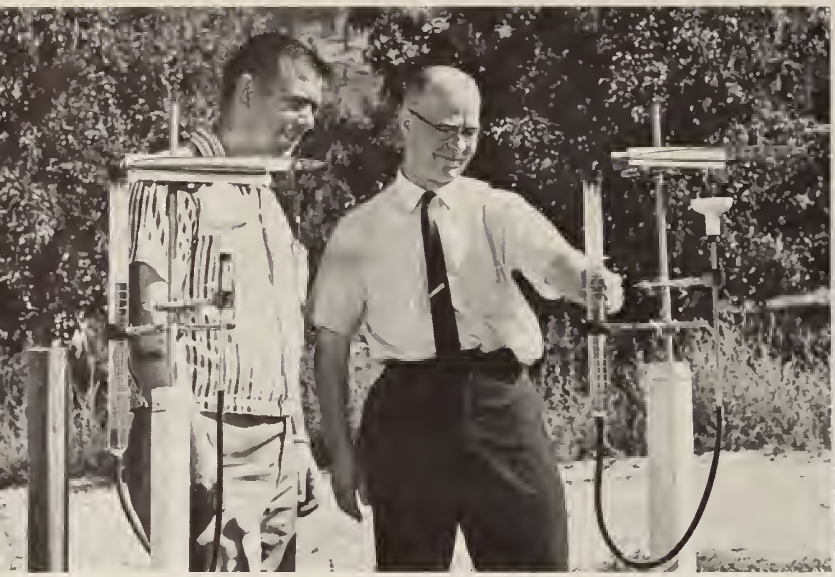


Fig. 1.—C.H. Brownlee (B.C. Soil Survey Staff, Kelowna) and J.C. Wilcox (right) examine evaporimeter used by Osoyoos irrigation district.

SCHEDULING IRRIGATION

USING EVAPORIMETERS IN B.C.

J. C. WILCOX

By "scheduling of irrigation" we mean the application of water at the right time and in the right amount. By the right time, we mean irrigating at the proper moment so the plants do not suffer from lack of water in any part of the field. By the right amount, we mean just enough water so that only a little of it drains away into the deeper subsoil after an irrigation.

Scheduling is accomplished in the Okanagan Valley by recording evaporation and rainfall, and by keeping a balance sheet of soil moisture credits and debits. The credits are for irrigation and rain, and the debits for daily water use from the soil. When the balance reaches zero (about 50% available moisture), we consider it time to irrigate.

Scheduling of irrigation in the Okanagan Valley has been beset with difficulties not usually mentioned in reports from elsewhere. Chief among these have been variations in climate and in soils, of sufficient magnitude that the number of irrigations per year varies from as few as one in a clay loam soil in a cool year to as many as 30 in a sandy soil in a hot year.

CLIMATIC VARIATIONS

In our investigations at the Summerland Research Station, we have been getting records from black bellani plate evaporimeters in 13 districts in the southern interior of British Columbia for several years. Wide differences in evaporation and rainfall have been found from district to district, as indicated by the representative districts shown in the accompanying table. The irrigation requirements shown in the last column have been estimated for sandy soils, using evaporation and rainfall data.

DIFFERENCES BETWEEN DISTRICTS
IN A TYPICAL YEAR
MAY TO SEPTEMBER*

District	Evaporation	Rain	Irrigation Required
	inches	inches	inches
Creston	43.2	9.0	15.0
Grand Forks	58.3	9.6	21.0
Osoyoos	87.4	3.6	40.0
Oliver	79.3	4.2	35.0
Summerland	69.8	5.5	29.9
Vernon	63.9	6.8	25.5
Salmon Arm	48.0	5.7	19.0

*1963

Dr. Wilcox is a specialist in sprinkler irrigation, CDA Research Station, Summerland, B.C.

Even within a district, evaporation and rainfall have been found to be quite variable. For example, the 35.0 inches irrigation requirement shown for Oliver is an average of the values from five locations, ranging from 29.5 to 42.7 inches. This means that in many districts no one location can represent the whole district adequately.

To complicate the problem still more, wide variations in the weather have been found from year to year. At Summerland, for example, the irrigation requirements for sandy soils have been as follows:

1958—42.3 inches
1959—29.8 inches
1960—33.0 inches
1961—38.4 inches
1962—30.9 inches
1963—29.9 inches
1964—25.2 inches
1965—28.4 inches

For scheduling purposes, the driest part of the driest year determines the peak flow incorporated into the system design, and the greatest annual irrigation requirement determines the water storage requirements.

SOIL VARIATIONS

Within each district, the soil varies widely in texture and depth. Hence the irrigation practices must vary accordingly. We have found that the coarser the soil texture, (a) the more frequently is irrigation needed, (b) the less water is needed at each irrigation, (c) the lower is the sprinkler application efficiency, and (d) the more water is needed during the season. With tree fruits at Summerland, a coarse loamy sand has about a 6-day safe interval, with a requirement of about 2.1 inches per irrigation and 47 inches per season; whereas a deep silt loam has a 30-day safe interval with requirements of 5.1 inches per irrigation and only 18 inches per season.

From 1959 to the present, experiments have been conducted at Summerland, Oliver, and Osoyoos to determine the minimum ratio of irrigation in inches to evaporation in inches (the I/E ratio). The procedure used has been to start with a higher ratio than needed, then to reduce it year by year until the lowest safe values are reached as judged by soil moisture and plant condition. These minimum I/E ratios have now been reached in most of the 17 orchards under test. The ratios now in use are shown in an accompanying chart. It will be seen that the values vary widely and are closely dependent on the frequency of irrigation. This means that under our variable soil conditions, no one value for the I/E ratio or for irrigation efficiency can prove suitable for use throughout a district. This has held true even for a perennial crop such as alfalfa or tree fruits.

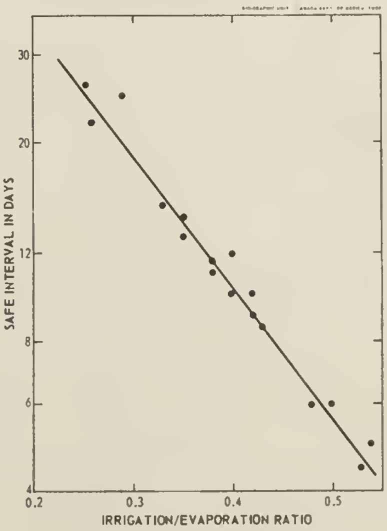
PRACTICAL APPLICATION OF RESULTS

The experimental work we have done thus far has indicated that substantial amounts of both water and operating time can be saved by scheduling. As compared with steady irrigation, scheduling saved 25% of the water and time in 1962, 28% in 1963, and 52% in 1964, a cooler summer than usual. These savings are produced by keeping the sprinkler lines idle whenever the balance sheets indicate that this can safely be done. As far as practical application is concerned, the difficulties resulting from our special problems in British Columbia seemed, at first, to be almost insurmountable. With the help of the staff of the B.C. Department of Agriculture, however, we have been able to develop a procedure that was used satisfactorily in one Irrigation District last year and is being used in three Districts this year (1965).

This procedure consists of setting up evaporimeters and rain gauges at one or more locations in each Irrigation District, setting up one or more large bulletin boards at locations suitable to the growers, and entering the required records on the bulletin boards daily. The growers copy the records as they need them, and use them for keeping their balance sheets and for deciding when to irrigate. Because of soil differences, each grower must be given specific instructions including the credit to give on the balance sheet when he irrigates. To be on the safe side, we use I/E ratios higher than those shown in the accompanying chart.

Personal help is given to each grower by Mr. C. H. Brownlee of the B.C. Soil Survey staff at Kelowna, not only in keeping the balance sheets but in assessing the adequacy of the sprinkler system, in recommending improvements to the system and in helping with various other problems as they arise during the season. Mr. Brownlee reports that he hopes to help one or more Irrigation Districts get started on the scheduling each year.

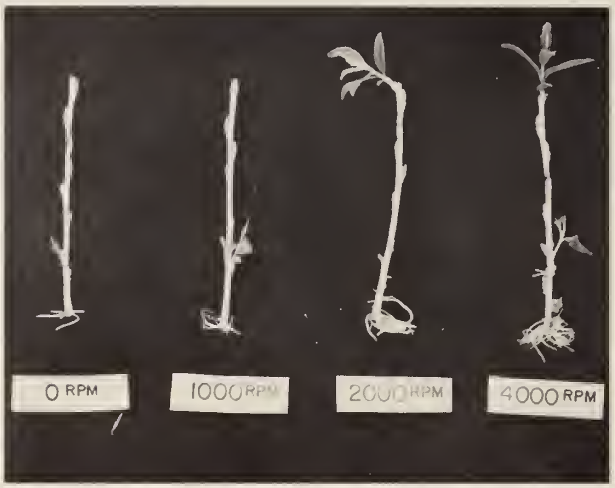
Partly because of the interest in scheduling, a quiet revolution in sprinkler irrigation is under way in southern British Columbia. ●



Ratio of irrigation to evaporation, plotted against safe irrigation interval.

EAR TO THE GROUND

INTERESTING RESEARCH HIGHLIGHTS



One hour of centrifugation at 0, 1,000, 2,000 and 4,000 r.p.m. produces 2.0, 4.4, 7.1 and 12.3 roots.

CENTRIFUGAL FORCE HELPS TO ROOT CUTTINGS—Rooting of woody cuttings (including many species of willow and poplar) is improved by using centrifugal force. This recent finding at Morden, Man., may be of much help in the nursery industry, and could also lead to the discovery of important data concerning the compounds in plants which promote rooting.

During trials, centrifugal force, acting from the tip to the base, was applied to willow cuttings. As the force increased, so did the number of roots produced by the cuttings. After one hour of centrifugation at 0, 1,000 2,000 and 4,000 revolutions per minute, the number of roots was 2.0, 4.4, 7.1 and 12.3 respectively.

Apparently at least two substances promote rooting in willows and other relatively easy-rooting species. One is known to be a plant hormone, but as yet the other cannot be identified. It has been shown that this second substance is forced to the base of the cutting by centrifuging.

It has also been shown that it is not present in some species more difficult to root than willow or poplar. Attempts to isolate it are underway at this station so it can be used to help rooting of difficult species.

—Makato Kawase, Morden, Man.

LE CONTRÔLE DE LA TACHE ARGENTEE DES POMMES DE TERRE—Les nombreux essais poursuivis dans différents types de sols, vierges et en culture depuis plusieurs années, en vue de contrôler la tache argentée des pommes de terre (*Helminthosporium atrovirens*) ont démontré que la jachére, la rotation avec céréals, la désinfection du sol par la fumigation ou l'emploi d'autres fongicides sont absolument sans effet sur l'incidence de la maladie.

Ceci confirme l'importance du tubercule de semence comme source d'inoculum. Si un tubercule de semence est sain, la récolte l'est également. Lorsque le tubercule mère est infecté, la récolte l'est plus ou moins selon que les pluies sont plus ou moins fréquentes au cours de la période de croissance des tubercules, et que la date de l'arrachage est plus ou moins tardive.—J. Santerre, La Pocatiére, Que.

SIMAZINE EFFECTIVE ON STRAWBERRIES—When properly applied, Simazine shows great promise as an effective herbicide for commercial use in eastern strawberry plantings. This was determined by detailed studies on timing, rates of application, and herbicide formulation, at the CDA Research Station, Fredericton, N.B.

Simazine controlled weeds effectively after treatments of one pound or more of active ingredient per acre, but the herbicide must be applied cautiously, to avoid crop injury and reduced yields. Best results were obtained by not applying simazine until six weeks or so after planting, and by splitting treatments into two applications, each at the rate of 0.5 pound of active ingredient.

The two sprays or granular applications were made six weeks after planting. Single applications of the granular form showed considerable promise for safe use at rates as high as 1.5 pounds of active ingredient per acre.

—W. B. Collins, Fredericton, N.B.